MINOR NOTICES

The fresh-water flora of Germany, Austria, and Switzerland.—PASCHER[5] has begun the publication of a series of brochures dealing with the fresh-water flora of Germany, Austria, and Switzerland, assisted by numerous specialists. The plan includes 16 parts, 4 of which have just appeared: no. 2 (pp. 192. *figs. 398*), Flagellatae 2, by A. PASCHER (Chrysomonadinae, Crytomonadinae, and Chloromonadineae) and E. LEMMERMANN (Eugleninae); no. 3 (pp. 66. *figs. 69. M* 1.80), Dinoflagellatae (Flagellatae 3), by A. J. SCHILLING; no. 9 (pp. 51. *figs. 89. M* 1.80), Zygnemales, by O. BORGE and A. PASCHER; no. 10 (pp. 192. *figs. 398. M* 4), Bacillariales (Diatomeae), by H. v. SCHÖNFELDT. The numerous illustrations and analytical keys should make the recognition of forms comparatively easy.—J. M. C.

William Russell Dudley.—Leland Stanford Junior University has published a "Dudley Memorial Volume," containing a paper by the late Professor DUDLEY and appreciations and contributions by friends and colleagues. The list of scientific papers is as follows: "The vitality of *Sequoia gigantea*," by W. R. DUDLEY; "The morphology and systematic position of *Calycularia radiculosa*," by D. H. CAMPBELL; "Studies of irritability in plants. III. The formative influence of light," by G. J. PEIRCE; "The gymnosperms growing on the grounds of Stanford University," by LEROY ABRAMS; "The Synchytria in the vicinity of Stanford University," by JAMES MCMURPHY; "The law of geminate species," by D. S. JORDAN; "Some relations between salt plants and salt spots," by W. A. CANNON; "North American species of the genus *Amygdalus*," by W. F. WIGHT.—J. M. C.

NOTES FOR STUDENTS

Cultures of the Uredineae.—The publications of 1912 on cultural work with the plant rusts show an increasing tendency in all parts of the world to clear up by systematic efforts rather than by sporadic cultures the problems of biological relationships in this group of parasitic fungi. In the United States, ARTHUR, who for many years has been prominently associated with this field of research, reports[6] six species which either have been shown to be autoecious or have been connected with their antithetic generation for the first time. These are as follows:[7] *Puccinia Lygodesmiae* Ellis et Ev. from *Lygodesmia juncea* (Pursh) D. Don produced teleutospores on the same host without the intercalation of pycnidia or other spore forms. Aecidiospores of *Aecidium monoicum* Peck from *Arabis* sp. produced uredinia and telia on

[5] PASCHER, A., Die Süsswasser-Flora, Deutschlands, Osterreichs, und der Schweiz. Parts 2, 3, 9, and 10. Jena: Gustav Fischer. 1913.

[6] ARTHUR, J. C., Cultures of Uredineae in 1911. Mycologia **4**:49–65. 1912.

[7] Unless otherwise stated, teleutosporic material was used in making the infections and the teleutosporic host is given first.

Trisetum subspicatum (L.) Beauv. and *T. majus* (Vasey) Rydb.; the species is described as *Puccinia monoica* (Peck) Arthur. *Gymnosporangium Nelsoni* Arth. (*G. durum* Kern) from *Juniperus utahensis* (Engelm.) Lemmon produced only pycnidia on *Amelanchier vulgaris* Moench. *Gymnosporangium effusum* Kern from *Juniperus virginiana* L. produced only pycnidia (*Roestelia transformans* Ellis?) on *Aronia arbutifolia* (L.) Ell. *Gymnosporangium gracilens* (Peck) Kern et Bethol. from *Juniperus monosperma* (Engelm.) Sarg. produced pycnidia and aecidia on *Philadelphus coronarius* L. In addition to these, cultures of 15 species are reported as confirming previous work.

FRASER,[8] who has been investigating the rusts in Canada, especially those inhabiting conifers, reports the following species whose relations have been worked out for the first time. *Necium Farlowii* Arthur from *Tsuga canadensis* sown on the same host produced only teleutospores but no pycnidia. *Melampsoropsis* (*Chrysomyxa*) *Pyrolae* (DC.) Arth. from *Pyrola americana* Sweet and *P. elliptica* Nutt. produced pycnidia and aecidia (*Peridermium conorum-Piceae* [Schw.] Arth.) on cones of *Picea mariana* (Mill.) B.S.P. and *P. canadensis* (Mill.) B.S.P. *Pucciniastrum minimum* (Schw.) Arth. from *Rhodora canadense* (L.) B.S.P. produced aecidia (*Peridermium Peckii* Thüm.) on leaves and cones of *Tsuga canadensis* (L.) Carr. *Uromyces Spartinae* Farl. from *Spartina Michauxiana* Hitch. infected *Arenaria lateriflora* L., but failed to infect *Spergularia canadensis* (Pers.) Don, while the same rust from *Spartina patens* (Ait.) Muhl. and *S. glabra* var. *alterniflora* (Loisel) Merr. infected *Spergularia canadensis*, but failed to infect *Arenaria lateriflora* L. *Melampsora arctica* Rostr. from *Salix discolor* Muhl. produced pycnidia and aecidia (*Caeoma* sp.) on *Abies balsamea* (L.) Mill. *Melampsora* (*Medusae* Thüm?) from *Populus grandidentata* Michx. produced pycnidia and aecidia (*Caeoma Abietis canadensis* Farl.) on *Tsuga canadensis* (L.) Carr., and in one case pycnidia on *Larix laricina*. Cultures confirming former work are reported for 12 species.

Of great interest is the discovery of the relation between certain fern rusts and the aecidial forms known as *Peridermium balsameum* Peck on *Abies balsamea* (L.) Mill. This relationship, suggested in this paper, is confirmed in a later note,[9] in which it is stated that *Uredinopsis Osmundae* Magnus, *U. Struthiopteridis* Störmer, *U. Phegopteridis* Arthur, *U. mirabilis* (Peck) Arthur, and *U. Atkinsonii* Magnus have as their aecidial stages forms of *Peridermium balsameum* Peck on *Abies balsamea*. A complete account is promised.

HEDGCOCK[10] succeeded in establishing the relation between *Peridermium filamentosum* Peck and the *Cronartium* on species of *Castilleja*. The aecidi-

[8] FRASER, W. P., Cultures of heteroecious rusts. Mycologia **4**:175–193. 1912.

[9] ———, Note on the life histories of the fern rusts of the genus *Uredinopsis*. Science N.S. **36**:595. 1912.

[10] HEDGCOCK, G. C., The *Cronartium* associated with *Peridermium filamentosum* Peck. Phytopathology **2**:176–177. 1912.

ospores were sown on two unidentified species of *Castilleja* and produced uredinia of a species of *Cronartium* for which the name *C. filamentosum* is proposed.

In Europe several papers on cultural work with rusts have appeared. Prominent among them is a paper by KLEBAHN,[11] who reports the results of cultural experiments carried out from 1907 to 1911. Many of the results are new, while others confirm or supplement the work previously published by the author or other investigators. Unfortunately, the presentation is not sufficiently clear and concise to enable one to distinguish those which are new from those which confirm other work. In this respect the reports of ARTHUR, and likewise that of FRASER, might well serve as models. The main results given in the paper are summarized here. *Uromyces Pisi* (Pers.) DeBary, sown on the young subterranean shoots of *Euphorbia Cyparissias* L. in the spring of 1906, produced the usual deformations with pycnidia and aecidia in the spring of 1907, thus confirming the work of JORDI. Aecidiospores from this culture infected *Pisum sativum* L. In another experiment *Lathyrus vernus* Bernh. was infected by aecidiospores from *E. Cyparissias* collected in another locality. This result suggests that several forms of *Uromyces* have their aecidia on that host. *Uromyces lineolatus* (Desm.) Schroet. from *Scirpus maritimus* L. infected *Berula angustifolia* Koch, *Oenanthe aquatica* Lamarck, and *Hippuris vulgaris* L. Aecidiospores of *Puccinia argentata* (Schultz) Winter from *Adoxa Moschatellina* L. infected leaves of *Impatiens nolitangere* L. and the subterranean shoots but not the developing leaves of *Adoxa*. It appears, therefore, that the infection of *Adoxa* takes place only in the subterranean parts. A form of *Puccinia* on *Carex crinita* Lam. infected *Ribes aureum* Pursh, *R. alpinum* L., *R. Grossularia* L., and *R. Cynosbati* L. This type, which was described by ARTHUR as *P. albiperidia*, the author does not regard as distinct from *P. Ribesii-Caricis* Kleb. Another form which had not been tested, and which was collected on *Carex teretiuscula* Gooden., produced aecidia on *Ribes rubrum* L., *R. alpinum* L., and also on *Urtica dioica* L. This was therefore a mixture of *P. Ribesii-Caricis* and *P. Urticae-Caricis*. A *Puccinia* from *Carex ligerica* Gay produced aecidia on *Taraxacum officinale* Web. This rust, therefore, belongs to *Puccinia silvatica* Schröter, which is a collective species whose forms have not been separated. *Puccinia Polygoni amphibii* Pers. on *Polygonum amphibium* L. infected *Geranium Phaeum* L., *G. pratense* L., and *G. sanguineum* L., while *Puccinia Polygoni* Alb. et Schwein. from *Polygonum Convolvulus* infected *Geranium molle* L., but none of the others.

The existence of specialized forms of *Puccinia Smilacearum-Digraphidis* Kleb. was confirmed in the following manner. Aecidiospores from *Paris quadrifolia* L. produced an abundance of teleutospores on *Phalaris arundinacea*. The teleutospores from this culture produced aecidia freely on *Paris quadri-*

[11] KLEBAHN, H., Kulturversuche mit Rostpilzen. Zeitschr. Pflanzenkrankh. **22**:321–350. 1912.

folia and *Polygonatum multiflorum*, but sparsely on *Convallaria majalis* L. and *Majanthemum bifolium* Schmidt. Teleutospores of the same species from another region infected *Convallaria* freely, but produced only yellow spots on the other three liliaceous plants. Aecidiospores of *Puccinia Symphyti-Bromorum* F. Müller from *Symphytum officinale* L. infected *Bromus inermis* Leyss., *B. erectus* Huds., *B. rigidus* Roth, and *B. mollis* L., thus confirming the relation between this aecidium and the brome rusts. Out of 15 species of plants on which *Puccinia persistans* Plowright from *Agropyrum repens* Beauv. was sown, only *Thalictrum flavum* L. was infected.

With the crown rusts of grasses the following cultures were made. (1) Aecidiospores obtained by sowing *Puccinia coronata* f. *agrostidis* Erikss. from *Agrostis vulgaris* With. on *Rhamnus Frangula* (*Frangula Alnus* Mill.) infected only *Agrostis alba* L. of the 8 grasses used. Since plants of *Calamagrostis* were not infected, this result is further evidence for the distinctness of the forms of crown rusts on *Agrostis* and on *Calamagrostis*. (2) Aecidiospores obtained by sowing *Puccinia coronifera* f. *Lolii* Erikss. on *Rhamnus cathartica* L. infected *Lolium perenne* L., *L. temulentum* L., *Festuca elatior* L., and *Holcus lanatus* L. This confirms the results of other experiments that the crown rusts known as the forms *Lolii* and *Festucae* are not well differentiated. (3) Aecidiospores obtained by sowing *Puccinia coronifera* f. *Holci* Kleb. from *Holcus lanatus* L. on *Rhamnus cathartica* infected both *Holcus lanatus* and *Lolium perenne*, showing that the forms *Holci* and *Lolii* are likewise not sharply differentiated. (4) A crown rust on *Arrhenatherum elatius* Mert. et Koch was found to produce aecidia on *Rhamnus cathartica*, and thereby proved to belong to *Puccinia coronifera* Kleb. Since the aecidiospores infected *Arrhenatherum elatius* but none of the other grasses subject to the attacks of crown rusts, this is considered by the author as a special form, *Arrhenatheri*.

Cultures with *Phragmidium Rubi* (Pers.) Winter, *P. violaceum* (Schultz) Winter, and *Kuehneola albida* (Kühn) Magnus on some 26 species of *Rubus* showed that no specialized races exist within the species in these rusts; the species, however, show differences in their behavior toward different species of *Rubus*. *Phragmidium Rubi* infected *Rubus caesius* L. and the species of the CORYLIFOLII group, but only rarely the species of other groups. *P. violaceum* infected most of the other species but not *R. caesius*, and only rarely the members of the CORYLIFOLLII group. *Kuehneola* infected nearly all the species. Sowing of aecidiospores of *Melampsora vernalis* Mieszl. from *Saxifraga granulata* L. on the same host confirmed the experiments of PLOWRIGHT and of DIETEL according to which this rust is autoecious. A number of cultures did not give positive results. Sowings of uredospores of *Uromyces Alchemillae* (Pers.) Winter on *Alchemilla* gave no infection, although successful infections have been previously reported both by the author and by FISCHER. The life history of this fungus, whose mycelium is perennial in the rootstocks of *Alchemilla*, has not been sufficiently cleared up. *Puccinia Tanaceti* DC. from *Tanacetum*

vulgare L. failed to infect that host. *P. Pringsheimiana* Kleb. grown on *Carex acuta* L. failed to infect *Ribes nigrum* L., although *R. Grossularia* L. was freely infected. An attempt to confirm LIRO's observation that *Pedicularis palustris* L. is the teleutospore host of *Peridermium Pini* Willd. (Kleb) was not successful. Sowings of aecidiospores on a number of other possible hosts resulted in failure, so that the teleutospore host of this important rust is still unknown. Aecidiospores of *Aecidium Circaeae* Ces. from *Circaea lutetiana* L. failed to infect *Brachypodium silvaticum* R. Sch., which was regarded as a possible alternate host for this fungus.

In conclusion, the author adds some observations on the wintering of uredospores of grain and other rusts. The uredospores of *Melampsoridium betulinum* (Pers.) Kleb., *Melampsora Larici Tremulae* Kleb., *Thecopsora Vaccinii* (Alb. et Schw.) Winter, and *Kuehneola albida* (Kühn) Magnus were incapable of surviving the winter. Some observations on an unknown species of *Melampsora* on *Populus alba* L. indicate that the mycelium of this fungus persists in the buds and produces uredinia on the unfolding leaves. All attempts to infect grasses with teleutospores of *Puccinia graminis* failed. To account for the appearance of the grain rusts in spring it has been suggested that the fungus is carried over with the seed. To test this hypothesis further, the author planted a number of plots with seed from plants badly infected with rust, but the young plants were free from rust in every case.

FISCHER publishes two papers on the specialization of certain rusts. The first[12] deals with specialization of forms within the collective species *Puccinia Saxifragae* Schlecht. inhabiting various European species of *Saxifraga*. DIETEL and H. and P. SYDOW have shown that the forms associated under that name can be separated into a number of species morphologically well marked. The possibility that within these species there might exist physiological races not morphologically distinguishable led FISCHER to investigate the *Puccinia* on *Saxifraga stellaris* in Norway. Sowings of the teleutospores were made on *S. stellaris*, *S. rotundifolia*, *S. androsacea*, *S. nivalis*, and *Aizoon longifolia*. Only *S. stellaris* was infected. In the course of these experiments, FISCHER observed that the newly formed teleutospores germinated immediately and continued during the entire summer to infect the leaves of the plants on which they were borne. The teleutospores of this species, therefore, act indifferently like those of a micro-*Puccinia* or of a lepto-*Puccinia*. A differentiation of the teleutospores into persistent and caducous types, which occurs in other species with teleutospores of similar behavior, does not occur in this species.

In the second paper[13] FISCHER gives further results of his investigations on the life histories of forms of *Uromyces caryophyllinus* (Schrank) Winter.

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[12] FISCHER, ED., Beiträge zur Biologie der Uredineen. 2. Zur Biologie von *Puccinia Saxifragae* Schlecht. Mycol. Centralbl. 1:277–284. 1912.

[13] ———, Beiträge zur Biologie der Uredineen. 3. Die Specialization des *Uromyces caryophyllinus* (Schrank) Winter. Mycol. Centralbl. 1:307–313. 1912.

Formerly FISCHER[14] had shown that the aecidiospores of the aecidium on *Euphorbia Gerardiana* collected in a district of Switzerland infected *Saponaria ocymoides*, but not other members of the pink family. Later, in a preliminary paper,[15] he described the successful infection of *Tunica prolifera* by aecidiospores from the same *Euphorbia* collected in another region (near Heidelberg). The existence of specialized forms within the species *Uromyces caryophyllinus* suggested by this experiment was confirmed by the experiments reported in the present paper. In this series of cultures the aecidiospores from *Euphorbia Gerardiana* collected near Heidelberg were sown on plants representing 10 species of the Caryophyllaceae, but only *Tunica prolifera* was infected. In single instances one uredo pustule was observed on *Saponaria ocymoides* and one on *Tunica Saxifraga*. A repetition of sowings of aecidiospores, collected in the region from which the material first used to infect *Saponaria ocymoides* was obtained, resulted in a doubtful infection of *Saponaria*, but a fairly abundant infection of *Tunica prolifera*. It is probable, therefore, that this material consisted mostly of the *Tunica*-form. These experiments show that *Uromyces caryophyllinus* consists of at least two biologic forms, one *Tunica prolifera*, rarely infecting *Saponaria ocymoides*, and one on *S. ocymoides*, whose relations to *Tunica prolifera* are not fully known.

SCHNEIDER[16] reports the following results of cultures of rusts infecting liliaceous plants. *Uromyces Scillarum* (Grev.) Winter, which occurs on various species of *Muscari* and *Scilla*, infected only *Muscari racemosum*, the species from which the material had been obtained. The teleutospores were found to germinate either immediately or after a period of dormancy. *Puccinia Schroeteri* Passerini from *Narcissus radiiflorus* infected also *N. pseudonarcissus*. *Puccinia Allii* (DC.) Rudolphi is reported by SYDOW as occurring on 27 species of *Allium*. Teleutospores from *Allium sphaerocephalum* produced uredinia on that species and also on *A. sativum*, *A. hymenorrhizum*, *A. oleraceum*, and *A. fistulosum*. In one case pycnidia and aecidia appeared on *A. sativum*. Uredospores of *Puccinia Porri* (Schw.) Winter from *Allium Schoenoprasum* infected *A. Schoenoprasum*, and to a less degree *A. ampeloprasum*, *A. sphaerocephalum*, *A. strictum*, *A. montanum*, *A. fistulosum*, *A. oleraceum*, and *A. hymenorrhizum*. In one case, a sowing of teleutospores from *A. Schoenoprasum* on plants of that species resulted in the production of aecidia. This fact is of interest, since TRANZCHELL,[17] as a result of experiments with the same form, found that no aecidia were formed, whence he concluded that this was a true hemi-*Puccinia*. The existence of hemi-forms is therefore still in doubt.

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[14] Rev. BOT. GAZ. **53**:79. 1912.

[15] FISCHER, ED., Über die Specialization des *Uromyces caryophyllinus* (Schrank) Winter. Mycol. Centralbl. **1**:1, 2. 1912.

[16] SCHNEIDER, W., Zur Biologie der Liliaceen bewohnenden Uredineen. Centralbl. Bakt. **32**:452, 453. 1912.

[17] Rev. BOT. GAZ. **53**:80. 1912.

TREBOUX,[18] working at Nowotscherkassk in southeastern Russia, reports the results of a number of infection experiments carried out in that region. Since the literature on the subject was not available to him, he was unable to consider the work of former investigators. The following is a list of the successful infections. Aecidiospores from *Ranunculus illyricus* L. infected *Festuca ovina* L. (*Uromyces Festucae* Syd.). Aecidiospores from *Sium lancifolium* MB. infected *Scirpus maritimus* L. (*Uromyces lineolatus* [Desm.] Schroet.). Aecidiospores from *Euphorbia virgata* W.K. infected *Astragalus hypoglottis* L. (*Uromyces Astragali* [Opiz.] Sacc.). In former experiments, uredospores from *Astragalus virgatus* Pall. infected *A. cicer* L., *A. glycyphyllus* Pall., *A. ponticus* Pall., *A. cruciatus* Link., *A. hamaeus* L., *A. placatus* Lam., *A. tianchanicus* Bunge., *A. viciaefolius* DC., and *A. virgatus* Pall. Apparently there is no specialization of forms within this species of *Uromyces*. Aecidiospores from *Euphorbia virgata* W.K. and *E. Gerardiana* Jacq. infected *Caragana frutescens* DC. (*Uromyces Genistae-tinctoriae* [Pers.] Fuckel). Other leguminous plants, including *Astragalus* and *Medicago*, were not infected either by aecidiospores or by uredospores. Aecidiospores from another aecidium on *Euphorbia virgata* infected *Medicago falcata* (*Uromyces striatus* Schroet.), but not *Astragalus, Caragana,* and others. Aecidiospores from *Cichorium Intybus* L. infected *Juncus Gerardi* Lois (*Puccinia Junci* [Strauss] Winter). A sowing of aecidiospores from *Taraxacum serotinum* W.K. produced only uredospores, probably those of *Puccinia silvatica* Schroet., on *Carex stenophylla* Wahlenb. Uredospores of *Puccinia Cesatii* Schroet. on *Andropogon Ischaemum* L., which had persisted during an unusually severe winter, were capable of germinating and infecting that host in spring. Apparently this rust lives through the winter in that region by means of uredospores which have thick walls. Teleutospores of *Puccinia Stipae* (Opiz.) Arthur from *Stipa Lessingiana* Trin. infected *Salvia aethiopis* L., *S. nutans* L., *S. silvestris* L., *Thymus serpyllum* L., and *Ajuga chia* Schreb.

STRELIN,[19] in a series of cultures, shows the relation between the primary uredinia (*Uredo Muelleri* Schroet.) and secondary uredinia and telia of *Kuhneola albida* (Kühn) Magnus, confirming the work of JACKY showing that these spore forms all belong to the same rust. STRELIN also shows that the fungus persists through the winter by means of the spores of the primary uredinia which are formed in July and August. The primary uredospores can infect the following spring only the old leaves which have persisted through the winter.—H. HASSELBRING.

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[18] TREBOUX, O., Infektionsversuche mit parasitischen Pilzen. I. Ann. Myc. **10**:73–76. 1912.

[19] STRELIN, S., Beiträge zur Biologie und Morphologie der *Kuehneola albida* (Kühn) Magn. und *Uredo Muelleri* Schroet. Mycol. Centralbl. **1**:92–96, 131–137. 1912.